INVESTIGATION OF THE DECAY OF Ru^{103} AND Rh^{103} WITH THE MAGNETIC LENS SPECTROMETER

BY

ALBERT JACKSON SAUR

B.S., Michigan State College, 1944
M.S., University of Illinois, 1947

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SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
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Introduction

The analysis of isobaric and isomeric transitions in nuclei is effected by comparing experiment with the following theories: (1) beta decay, (2) gamma ray lifetimes, (3) internal conversion of gamma rays, and (4) shell model of the nucleus. Shell model theory is the newest and the least well founded. Hence any inconsistencies among experiment and the four theories tend to cast doubt on shell model theory.

One test of shell model theory is the study of isomeric transitions. Such a study is contained in reference 1. In certain regions of the chart of nuclides, shell model theory predicts isomeric transitions with change of parity. Several such transitions have been discovered in which, if internal conversion and gamma ray theory is reliable, there is no parity change.

A case of interest is Rh^{103}. This nuclide has 45 protons for which shell model theory, as propounded in reference 2, predicts a $g_{9/2}$ ground state. All other states in the period ending with 50 like nucleons are p or f states. If an isomeric transition is to be understood to be a transition from one of the p or f states to the g state, a parity change is required. However, in ref. 1, Rh^{103} is classified in the $l = 4$ group of transitions, in which no parity change can occur. An important purpose of this work was, therefore, to gather more information about this particular transition.

Discussion

A lens-type beta-ray spectrometer and other instruments

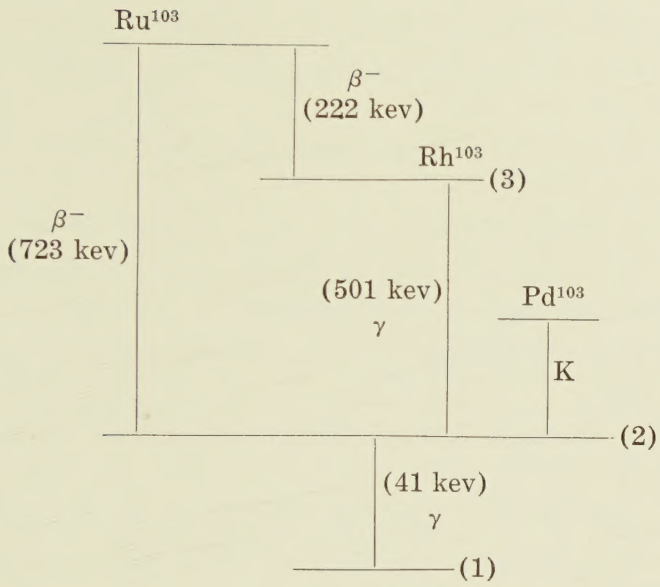
were used to investigate the decay of 42-day Ru^{103} and 17-day Pd^{103} to Rh^{103}. In agreement with the results given in refs. 3-5, two beta spectra were found in Ru^{103}. About 95% of the decay proceeded by way of a 222 ± 5 kev beta spectrum. The other 5% proceeded by way of a 723 ± 30 kev beta spectrum. A Kurie plot (ref. 6) of the low energy spectrum showed that it did not have a $(p^2 + q^2)$ shape. Hence, if it is a first forbidden beta transition (as has been assumed), the spin change is either 0 or 1 (see ref. 7).

Groups of conversion electrons were observed with the spestrometer. These electrons were interpreted as corresponding to gamma rays of energies 41 ± 1 and 501 ± 3 kev. The 501 kev gamma ray was also studied by observing the photoelectrons ejected from a .0005" gold foil. A stndy of the conversion electrons indicated that the 501 kev gamma ray could be electric quadrupole or magnetic dipole.

A study of rhodium separated chemically from Ru^{103} showed that the 41 kev gamma ray arose from a 49-minute isomeric transition in Rh^{103}. This isomeric transition has been reported in ref. 5, 8-12. Proportional counter studies of the K x-rays from Rh^{103} indicated a conversion coefficient of not less than 1500 electrons per gamma ray. The K/L ratio, as determined spectrographically, was 0.1. These data are sufficient to rule out an $l = 3$ assignment and are consistent with the $l = 4$ assignment of ref. 1.

A study of Pd^{103} indicated that it decayed by electron capture to the 49 minute isomer of Rh^{103}, in agreement with refs. 5, 13, 14.

The data are consistent with the following level scheme:



Shell model theory predicts that level (1) is $g_{9/2}$ and that levels (2) and (3) are probably p or f states. Hence, a parity change is predicted for the 41 kev transition. This prediction is inconsistent with the $l = 4$ assignment. The states of Ru^{103} and Pd^{103}, which have 59 and 57 neutrons respectively, are probably $d_{5/2}$ states. The 501 kev transition involves no parity change, and it has been assumed that both beta transitions are first forbidden, with a spin change of 1 for the 222 kev and 2 for the 723 kev transition.

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VITA

Albert Jackson Saur was born on March 11, 1923, at Kent City, Michigan. After graduating from Kent City High School in 1940, he entered Michigan State College and received from that institution the degree of Bachelor of Science, with high honor, in March, 1944. From April, 1944, to September, 1946, he was associated with the Underwater Sound Division of the Naval Research Laboratory in Washington, D. C. In September, 1946, he entered the Graduate College of the University of Illinois and received the degree of Master of Science from that institution in October, 1947. He held a half-time graduate teaching assistantship from September, 1946 to February, 1949, a Research Assistantship from February, 1949, to September, 1949, and an A.E.C. Predoctoral Fellowship from September, 1949, to September, 1950.

He is a member of Sigma Xi and of Phi Kappa Phi and is associated with the American Physical Society.

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